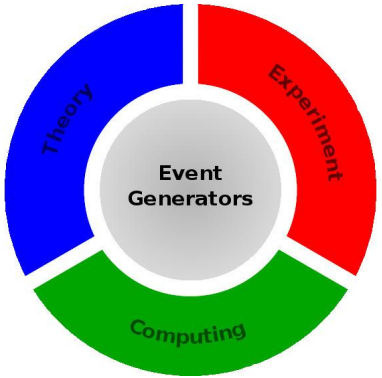
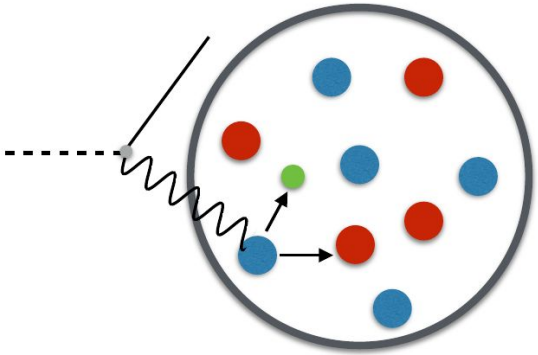
Neutrino Event Generators 2203.11110

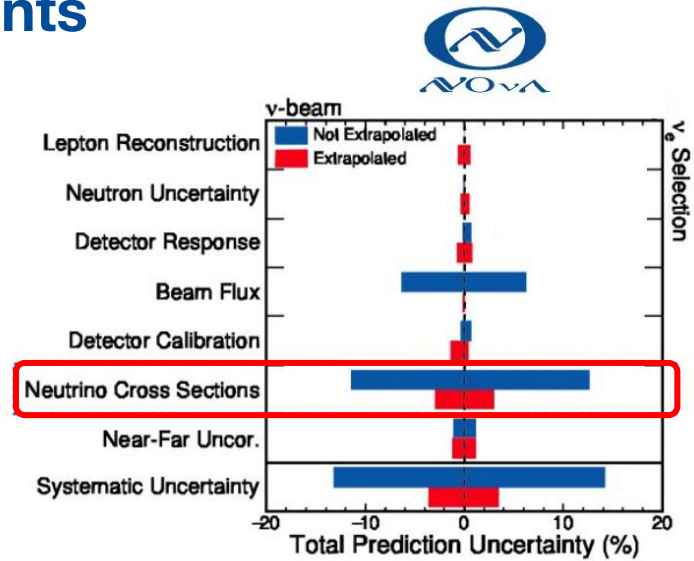
- HEP experiments rely on generators for design, analysis and interpretation of data
- Theory needs generators to connect to experiments
- **Generators are preserving the collective knowledge of high-energy particle physicists in a set of calculations and models that are implemented in publicly accessible open-source computer code (Open Science)**





Current Status and Future Requirements

- Current estimates of neutrino interaction modeling at 5-10%
- Reaching the goal of DUNE is possible but will require effort
- Must ensure continued support for development of simulations



From the DUNE CDR2 (1512.06148)

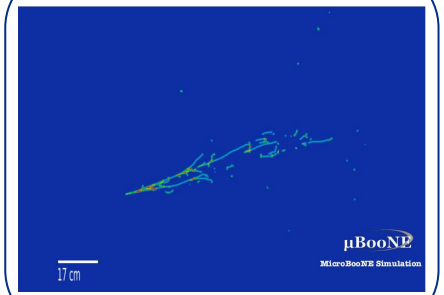
As illustrated in Chapter 3, studies on the impact of different levels of systematic uncertainties on the oscillation analysis indicate that uncertainties exceeding 1% for signal and 5% for backgrounds may result in substantial degradation of the sensitivity to CP violation and mass hierarchy. The

Exploring the unknown

- Pedro's Talk:
  - From a theory perspective, (LH) is special: it is a gauge-singlet
  - Neutrinos are one of the renormalizable portals to new physics
- **Have to be able to test any model reliably and quickly**
- Similar situation in collider community before start of LHC

  Lead to development of automated simulation toolchain

$$\mathcal{L}_{\mathcal{D}} \supset \frac{m_{Z_{\mathcal{D}}}^2}{2} Z_{\mathcal{D}\mu} Z_{\mathcal{D}}^{\mu} + g_{\mathcal{D}} Z_{\mathcal{D}}^{\mu} \overline{\nu}_{\mathcal{D}} \gamma_{\mu} \nu_{\mathcal{D}} + e\epsilon\, Z_{\mathcal{D}}^{\mu} J_{\mu}^{\mathrm{em}} + \frac{g}{c_W} \epsilon'\, Z_{\mathcal{D}}^{\mu} J_{\mu}^{Z}$$



Fermilab